concentration are all fixed ; a change in any one of these conditions results in the elimination of one phase ; or, if both temperature and pressure are made to change arbitrarily, equilibrium cannot be restored without the loss of two phases from the system. When two kinds of change may thus be made at pleasure, the system is said to be *divariant* and to have two degrees of freedom. It is here assumed that any disturbing effects due to gravity, electricity, capillarity or the distortion of solid masses are avoided, pressure and temperature being uniform throughout the system. The absolute and relative masses of the several phases have no effect upon equilibrium, except as some phase disappears entirely. The number of independent variables (including temperature and pressure) is two more than the number of components; and Gibbs' phase rule asserts that in the equilibrium of heterogeneous substances the number of degrees of freedom is equal to two more than the number of components, diminished by the number of phases. Thus, a non-saturated solution of a salt, in contact with vapor, may be altered at pleasure in regard to the concentration of the salt and either the temperature or the pressure; with two components in two phases, two arbitrary changes are subject to the will of the operator.

Le Chatelier's theorem asserts that "any change in the factors of equilibrium from outside is followed by a reverse change within the system." Thus, if a small amount of salt be added to the non-saturated solution, without change of temperature, this increase of concentration is offset in part by condensation of vapor and the pressure is therefore diminished. The system tends to return to its former condition of equilibrium by elimination of the disturbing element. Thus the sense of change resulting from the disturbance from conditions of equilibrium can be predicted, but the amount or rate of change involves quantitative relations which lie beyond the scope of the volume under review.

Experimental data are discussed, as indicated above, with regard to systems of one, two, three and four components. The relations of temperature, pressure and concentration are represented graphically. Much ingenuity has been shown in devising triangular diagrams to represent the relative masses of three substances by coördinates on a single plane. Melting and boiling points, critical temperature, allotropy, cryohydrates, solubility of anhydrous and hydrated salts, double salts, efflorescence, dissociation, supersaturation, volatile solutes, partially miscible liquids, eutectic mixtures and temperatures, fractional distillation, solid solutions, occlusion, alloys and fractional crystallization are among the subjects discussed, with numerous concrete examples.

The author's distinction between solvent and solute, or between solubility curve and fusion curve (as on pp. 36, 45, 95, etc.), does not find general acceptance. An attempt to determine the 'hypothetical line' of demarkation (page 158) may help to decide the point at issue.

While physical chemistry is rapidly gaining importance, many are deterred by the mathematical difficulties. To such, this work will give a welcome clew to the import of differential equations. Students of physical chemistry will here find a considerable field brought under review and duly systematized. Numerous indications are given of the present limitations of science and the open fields for profitable investigation.

ROBT. B. WARDER.

The Principles of Mathematical Chemistry; The Energetics of Chemical Phenomena. By DR. GEORG HELM. Authorized Translation by J. LIVINGSTONE R. MORGAN, PH. D. New York John Wiley & Sons; London, Chapman & Hall, Limited. 1897. 12mo. Pp. viii+228. Price, $1.50.

The original German edition has been recognized for three years or more as a work of value, and this translation will doubtless find a welcome. The principles of thermodynamics (including the conservation of energy) are asumed as the basis for the discussion. The intensity and quantity factors are distinguished in the various forms of energy, and the principle of constant or increasing entropy is applied to various reversible and non-reversible changes. Equations for chemical intensity are applied to electrolysis, simple chemical reactions, chemical equilibrium, freezing and boiling

points, vapor pressures, osmotic pressure, diffusion, speed of chemical reaction and to the phase rule.

ROBT. B. WARDER.

Observation on the Coloration of Insects. By BRUNNER VON WATTENWYL. Translated by EDWARD J. BLES, B.Sc., King's College, Cambridge. Leipsic, Engelmann. Fol. Pp. viii + 16. 9 plates.

In 1873, and again ten years later, Brunner published essays on 'hypertely,' or extravagance in nature, which are practically the foundation of the present work, in which an attempt is made to classify the fundamental phenomena of coloration in insects. These are treated of under the headings of uniform coloration, stripes and spots, the line of orientation ('indicating the position assumed by the insect in receiving its coloration'), strokes and dots, eyespots, spirals, splash marks, cloudings, stencil patterns, erosion, changes in pattern, enlargement or diminution of spots and bands, discoloration, diminution of patterns, changes due to adaptation, staining of contiguous parts, fading in covered parts, coloring in relation to position, and finally, as the summation of the whole, the arbitrariness of coloration. One quotation from the section on stencil patterns may be given as a good sample of his illustrations:

"In *Pseudocreobotra ocellata* Serv. one sees on the transparent, somewhat yellowish ground of the fore wings, firstly, a green patch, laid on as with a stencil. Then, in the middle of the green portion, opaque, citron yellow is laid on in the form of a spiral. The spiral is bordered with a heavy black line and in the center of the spiral there is a round spot of the same color.

"The black line obviously is meant to serve as a setting of the yellow spiral, yet careful examination reveals that the black marking is bodily shifted slightly inwards towards the insertion of the wing. For on this side, between the yellow spiral and the black line, a narrow strip of the green ground shows, while on the outer side the black border plainly encroaches upon the yellow ring. The shifting of the black marking is still more plainly shown by the small central spot not lying where it obviously should lie, but likewise shifted inwards.

"We have, consequently, three colors stencilled on the glassy wings: first green, then lemon yellow, and to complete the picture, a black body color; the latter is somewhat misfitted, as it may also be at times in our colored prints.

"I wish to lay stress on the agreement in this arrangement amongst all the many specimens which have passed through my hands. The idea can, therefore, not be entertained that the negligence described is a mere chance occurrence in one individual. The species was ornamented *once for all*, and just as it emerged from this operation, so has it been transmitted by inheritance."

He further mentions, in his final division, the case of an Acridian of the genus *Mastax*, in which a yellow stripe on the sides of the body includes the lower third of the facetted eyes, "and, as the stripe is formed by a body pigment, there is no doubt that the power of vision is destroyed in the part affected."

The author concludes that "the careless splashings, the defective stencil patterns or the impairment of vision by a band laid over the eyes and many other facts met with in the study of coloration cannot be brought into relation with any purposeful tendency. If one, therefore, calls modification through natural selection, Darwinism, a new name [Brunnerism?] must be introduced for the undoubtedly demonstrable occurrence of phenomena in the whole living world which have no relation to their owners or are occasionally harmful to them and hence are certainly not the result of selection."

Brunner combats the possibility of any gradual assumption of the more striking features, including the phenomena of mimicry, and, therefore, contends that they cannot be the result of natural selection; but he formulates no new law or process by which they can be presumed to have come into being, and so is forced to conclude that in the coloration of insects "we meet with an *arbitrariness* striving to produce attributes without regard for their possessors, and, therefore, obviously to be looked